J. Agrofor. Environ. 3 (1): 105-109, 2009 ISSN 1995-6983

Vegetable production on the ails of boro rice field and its effect on rice crop

M.A. Hasan and N. Islam[1]
Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dinajpur, [1]Department of Agronomy, Bangladesh Agricultural University, Mymensingh, E-mail: mahasan_uni@yahoo.com

Abstract: An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from December 2004 to May 2005 to investigate the performance of selected vegetables and different levels of width of *ail* in *Boro* rice cv. BRRI dhan29. The experiment comprised five crop combinations viz. rice alone i.e. control (C_0), rice + bottle gourd (C_1), rice + white gourd (C_2), rice + sponge gourd (C_3), and rice + yard long bean (C_4) and four levels of width of *ail* viz. 30 cm (A_1), 40 cm (A_2), 50 cm (A_3), and 60 cm (A_4). The experiment was set up using randomized complete block design with three replications. Vegetables included were raised on the *ails* of rice plots and later, these were given on to the trellis made with bamboo and plastic rope arrangements. The highest grain yield (6.94tha^{-1}) was obtained from the control treatment (C_0) and the lowest grain yield (5.71tha^{-1}) obtained from rice + yard long bean (C_4) crop combination, which was similar to rice + white gourd (C_2) crop combination. In vegetable production, the highest yield (15.73tha^{-1}) was recorded from rice + white gourd (C_2) and the lowest yield (2.28tha^{-1}) was received from rice + sponge gourd (C_3) crop combination. Results also showed that the highest grain yield (6.54tha^{-1}) was produced from the A_3 (50 cm) treatment, which was similar to A_4 (60 cm) treatment and the lowest grain yield (6.03tha^{-1}) was found in A_2 (40 cm) treatment. In terms of vegetable production, the highest vegetable yield (8.54tha^{-1}) was recorded from A_4 (60 cm) treatment, which was identical to A_3 (50 cm) treatment and the lowest value (4.95tha^{-1}) was received from A_2 (40 cm) treatment. On the contrary, the highest rice equivalent yield (15.22tha^{-1}) was obtained from A_4 treatment, which was similar to A_3 treatment and the lowest rice equivalent yield (11.24tha^{-1}) was found in A_2 treatment. The highest grain (7.21tha^{-1}) yield was obtained from C_0A_1 treatment combination and the lowest value (4.67tha^{-1}) was recorded from C_4A_2 treatment combination. The highest vegetable yield (18.78tha^{-1}) was recorded from C_2A_4 treatment combination (rice + white gourd and 60 cm width of *ail*) and lowest vegetable yield (1.59tha^{-1}) was obtained from C_3A_2 (rice + sponge gourd and 40 cm width of *ail*). On the other hand, the highest rice equivalent yield (23.75tha^{-1}) was obtained from C_2A_4 treatment combination and the lowest rice equivalent yield (6.65tha^{-1}) was received from the control treatment combination (C_0A_2). In respect of cost analysis for vegetable cultivation with *Boro* rice, the highest gross return (Tk. 208,985ha^{-1}), net return (Tk. 149,049ha^{-1}) and benefit-cost ratio (3.49) were obtained from the treatment combination of rice + white gourd and 60 cm width of *ail* (C_2A_4) and the lowest gross return (Tk. 74,030ha^{-1}), net return (Tk. 17,256ha^{-1}) and benefit-cost ratio (1.30) were obtained from rice + sponge gourd and 40 cm width of *ail* (C_3A_2) treatment combination.
Key words: Vegetable production, *Ail*, *Boro* rice crop

Introduction

Bangladesh is primarily a rice-producing country. Rice plays dominant role in Bangladesh agriculture covering about 76% of the total cropped area (BBS, 2004). The alarming population growth rate, rapid industrialization and urbanization have gradually been reducing the cultivable land. Bangladesh has the lowest per capita arable land due to its high population density. On the other hand, the sustainable vegetable crop production system in Bangladesh is lacking. Vegetable crops excluding potato occupy only 1.8% of the total cropped area with a gross production of 1.63million tons (BBS, 2004). In developed countries, cereals and vegetables including roots and tubers are produced in the ratio of 1:2 (by weight). The ratio in the developing countries of Asia is 2:1, but in Bangladesh it is 5:1 (Siddique and Aditya, 1992). The per capita consumption of vegetable in Bangladesh is only 53 g, which is far behind the daily requirement of 200 g/head/day (Rashid, 1999). The figure is lowest among the Asian countries like India (167 g), Pakistan (69 g), Sri Lanka (120 g), China (280 g) and Japan (248 g); the world average consumption being 250 g/head/day (FAO, 1998). The unavailability of land for vegetable production in wet season is the main constraint to maintain sustainability of year round vegetable production in Bangladesh. In spite of the intensive land use, the country is deficit in crop production and farm families are facing economic dislocation. This problem may be solved by producing high yielding vegetable crops simultaneously in the *ails* of rice field as mixed crops.

Moreover, Bangladesh is constrained with insufficient vegetable resources. Under these alarming situations, it is necessary to find out suitable alternatives. Since there is neither enough scope for expanding vegetable growing land nor sole grain crop areas, we have to develop a combined production system integrating vegetables and cereals. Increase in land area for vegetable production seems to have little scope, because of tremendous population pressure on the land. Thus in these circumstances, some unconventional methods may be explored to grow vegetable crops on the *ail*s (the border of the rice plots that is used for the control of water movement) of rice crops. So, this research work has of immense importance for food production in order to meet up the demand for ever-increasing population. It is probable that the production will be high with low cost. To provide balance diet for the people of Bangladesh is an important part, which might provide vitamins and minerals. Moreover, some vegetables have reasonable market price round the year. If sufficient vegetables can be grown without causing any or a little harm to rice production, it will be very helpful technology for the poor people of the country.

Therefore, it is of prime need to improve the system-based productivity and put emphasis not only on rice but also simultaneously on the production of vegetable crops within the set-up of rice production. Therefore, the proposed research work was undertaken to select the most suitable and adaptive type of vegetables from among the different vegetable crops that could be raised on *ails* of growing rice crops.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from December 2004 to

May 2005 to investigate the performance of some selected vegetables and different levels of width of *ail* in *Boro* rice cv. BRRI dhan29. The experiment comprised five crop combinations viz. rice alone i.e. control (C_0), rice + bottle gourd (C_1), rice + white gourd (C_2), rice + sponge gourd (C_3), and rice + yard long bean (C_4) and four levels of width of *ail* viz. 30 cm (A_1), 40 cm (A_2), 50 cm (A_3), and 60 cm (A_4). The experiment was set up in a randomized complete block design with three replications and the unit plots measured 4.0 m x 2.5 m each. Vegetables included were raised on the *ails* of rice plots and later, these were given on to the trellis made with bamboo and plastic rope arrangements. Trellises were made in the middle of the plot to minimize the shading effect on rice crop. *Boro* rice cv.BRRI dhan 29 was fertilized at the rate of 304, 77, 60, 29 and 5 kg ha^{-1} of urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate, respectively (BRRI, 2004). Except urea, the whole amount of other fertilizers was applied during final land preparation. Urea was top dressed at 20 and 55 days after transplanting of rice. Rice seedlings of 45 day-old were transplanted on 14 January 2005 in 25 cm apart rows with two seedlings $hill^{-1}$ maintaining hill distance of 15 cm. The pits on *ail*s were prepared with different fertilizers and manures according to dike cropping manual (Alam, 2000). Vegetable seeds were sown directly in the pit made on *ail*s of *Boro* rice field on February 2005 maintaining a distance of 50 cm from pit to pit. Intercultural operations were done and plant protection measures were taken as per requirement of the rice-cum-vegetable cultivation. Five rice hills were selected randomly from each plot and uprooted before harvesting for recording data other then yields. After sampling the whole plot was harvested at maturity on 19 May 2005. The harvested plants of each plot were separately bundled, properly tagged and then threshed and the fresh weights of grain and straw yields were recorded plot wise. The grain weight was assessed at a 14% moisture level. Finally, grain and straw yields were recorded and converted to t ha^{-1}. Here, vegetable yield assessment was made on the basis of whole plot. Rice equivalent yield, gross return, net return and benefit-cost ratio were also calculated. Data were analyzed and the mean differences were adjudged by Duncan's Multiple New Range Test (Gomez and Gomez, 1984).

Results and Discussion

Effect of vegetable crop combination

It was observed that crop combination exhibited significant influence on all the characters such as number of effective and total tillers $hill^{-1}$, number of grains $panicle^{-1}$, grain and straw yields along with vegetable and rice equivalent yields except plant height and panicle length (Table 1). The highest number of effective tillers $hill^{-1}$ (15.27) was obtained from control treatment (C_0), which was similar to rice + bottle gourd (C_1) crop combination and the lower number (13.95) received from rice + yard long bean (C_4), which was identical to C_2 (14.10) and C_3 (14.27) crop combinations. Total number of tillers $hill^{-1}$ was significantly affected by the crop combination (Table 1). The result showed that the maximum number of total tillers $hill^{-1}$ (18.04) was produced from the control treatment (C_0), which was similar to rice + bottle gourd (C_1) crop combination and the minimum number of total tillers $hill^{-1}$ (15.95) was produced from rice + yard long bean (C_4) crop combination that was identical to C_2 (16.42) and C_3 (16.22) crop combinations. There was no significant difference among the crop combinations except control treatment. The control treatment (C_0) produced highest grains $panicle^{-1}$ (144.0) than the other crop combinations. Results show that different crop combinations significantly reduced rice yields compared to that obtained from sole rice plots. On the contrary, significant rice yield reductions were observed in rice + white gourd (C_2) and rice + yard long bean (C_4). However, grain yield reductions due to trellis-grown vegetable were not much remarkable. Rice + yard long bean (C_4) crop combination produced the lowest grain yield (5.71 t ha^{-1}) with yield reduction of 18.0% as compared to sole rice cropping (Table 1). This result was similar to the findings of Kundu (2002). There was similar trend in straw yield as observed in grain yield of rice. Higher straw yield (7.97 t ha^{-1}) produced from the control treatment (C_0) and lower straw yield (6.60 t ha^{-1}) was obtained from rice + yard long bean (C_4) crop combination. Higher straw yield was attributed due to its higher number of total tillers $hill^{-1}$. This result was similar to that of Amin (2004).

Table 1. Yield and yield attributes of *Boro* rice cv. BRRI dhan29 as influenced by the crop combination in the rice cum vegetable cultivation system

Crop combination	Plant height (cm)	No. of effective tillers $hill^{-1}$	No. of total tillers $hill^{-1}$	Panicle length (cm)	No. of grains $panicle^{-1}$	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Vegetable yield (tha^{-1})	Rice equivalent yield (tha^{-1})	Reduction in interception of solar radiation (%)
C_0	92.17	15.27a	18.04a	22.96	144.0a	6.94a	7.97a	-	6.94d	-
C_1 (R + Bo)	91.10	14.97a	17.60a	23.20	136.7b	6.48b	7.45b	9.38b	15.31b	9.0
C_2 (R + W)	91.90	14.10b	16.42b	23.43	135.9b	5.97c	6.92c	15.73a	20.77a	11.0
C_3 (R + S)	91.25	14.27b	16.22b	23.59	136.0b	6.39b	7.34b	2.28d	8.53c	8.0
C_4 (R + Y)	91.95	13.95b	15.95b	23.41	133.0b	5.71c	6.60c	7.08c	15.70b	10.0
Level of significance	NS	0.01	0.01	NS	0.05	0.01	0.01	0.01	0.01	
CV (%)	2.49	3.71	3.93	3.60	4.95	6.94	6.65	22.95	12.60	

In a column, the treatment means having similar letter(s) do not differ significantly, 'NS' means not significant
C_0: Rice alone (Control), C_1: Rice + Bottle gourd (Bo), C_2: Rice + White gourd (W), C_3: Rice + Sponge gourd (S), C_4: Rice + Yard long bean (Y)

In vegetable production, white gourd (C_2) on the *ails* of rice plots gave the highest yield of 15.73 t ha^{-1} followed by 9.38 t ha^{-1} of bottle gourd (C_1). The production of yard long bean (C_4) was moderate (7.08 t ha^{-1}) and sponge gourd (C_3) had the lowest vegetable yield (2.28 t ha^{-1}). It is well to note that the yield of vegetable was slightly affected by hailstorm during the harvesting period. Rice + white gourd (C_2) gave the highest rice equivalent yield of 20.77 t ha^{-1} followed by 15.70 t ha^{-1} in rice + yard long bean (C_4) and 15.31 t ha^{-1} in rice + bottle gourd (C_1) and the lowest value (6.94 t ha^{-1}) was obtained from the control treatment i.e. sole rice (C_0). The result indicated that in most cases sole *Boro* rice is less profitable than the plots provided with vegetable. This result was similar to the findings of Kundu (2002). There was no significant difference among different crop combinations except control treatment i.e. sole rice (Table 1). It was observed that reduction in interception of solar radiation ranging from 8.0% to 11.0% was found among the treatments compared to the sole rice crop.

Effect of width of *ail*

Width of *ail* also exerted significant influence on all the characters of rice such as number of effective and total tillers $hill^{-1}$, number of grains $panicle^{-1}$, grain and straw yields along with vegetable and rice equivalent yields. Other characters were not significant (Table 2). Results showed that the highest number of effective tillers $hill^{-1}$ (14.96) was produced from the A_3 (50 cm) treatment followed by A_4 (14.56) and the lowest number of effective tillers $hill^{-1}$ (14.12), which was identical to A_1 (30 cm) treatment. There was no significant difference between A_3 (50 cm) and A_4 (60 cm) treatments. The lowest number of total tillers $hill^{-1}$ (16.04) was recorded from A_2 (40 cm) treatment (Table 2). Results showed that the maximum number of grains $panicle^{-1}$ (140.1) was produced from A_3 (50 cm) treatment, which was similar to that produced from A_4 (60 cm) and A_1 (30 cm) and the minimum value (132.2) was found in A_2 (40 cm) treatment. Results showed that the A_3 (50 cm) and A_4 (60 cm) width of *ail*s did not show significant difference in rice grain yields. On the other hand, significant grain yield reductions were achieved with A_1 (30 cm) and A_2 (40 cm) width of *ail*s (Table 4.5.3). The highest grain yield (6.54 t ha^{-1}) was produced from the A_3 (50 cm) treatment, which was similar to A_4 (60 cm) treatment and the lowest grain yield (6.03 t ha^{-1}) was found in A_2 (40 cm) treatment. Among width of *ail* treatments, except A_2 (40 cm) treatment the differences between treatments were not statistically significant. The maximum straw yield (7.45 t ha^{-1}) was obtained from A_4 (60 cm) treatment and the minimum value (6.91 t ha^{-1}) received from A_2 (40 cm) treatment. Width of *ail*s exhibited significant effect on vegetable yield (Table 2). The highest vegetable yield (8.54 t ha^{-1}) was recorded from A_4 (60 cm) treatment, which was identical to A_3 (50 cm) treatment and the lowest value (4.95 t ha^{-1}) was received from A_2 (40 cm) treatment. The probable cause might be that root growth and development of vegetable crops were much better in broader *ail*s than that of narrower ones. It was found that width of *ail* had significantly influenced rice equivalent yield (Table 2). Among width of *ail* treatments, the A_4 (60 cm) and A_3 (50 cm) treatments produced the highest rice equivalent yield (15.22 and 14.88 t ha^{-1}, respectively). On the other hand, the rest two treatments gave the lowest rice equivalent yields (12.46 and 11.24 t ha^{-1}, respectively).

Table 2. Yield and yield attributes of *Boro* rice cv. BRRI dhan29 as influenced by the width of *ail* in the rice cum vegetable

Width of *ail*	Plant height (cm)	No. of effective tillers $hill^{-1}$	No. of total tillers $hill^{-1}$	Panicle length (cm)	No. of grains $panicle^{-1}$	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Vegetable yield (tha^{-1})	Rice equivalent yield (tha^{-1})
A_1	91.03	14.40bc	16.64b	23.33	136.8ab	6.15bc	7.15ab	5.96b	12.46b
A_2	91.96	14.12c	16.04c	23.28	132.9b	6.03c	6.91b	4.95b	11.24b
A_3	92.79	14.96a	17.36a	23.47	140.1a	6.54a	7.51a	8.12a	14.88a
A_4	90.91	14.56b	17.33a	23.19	138.7a	6.47ab	7.45a	8.54a	15.22a
Level of sig.	NS	0.01	0.01	NS	0.05	0.05	0.01	0.01	0.01
CV (%)	2.49	3.71	3.93	3.60	4.95	6.94	6.65	22.95	12.60

In a column, the treatment means having similar letter(s) do not differ significantly, 'NS' means not significant,
Note: A_1: 30 cm, A_2: 40 cm, A_3: 50 cm, A_4: 60 cm

Interaction effect of vegetable crop combination and width of *ail*

Plant height, number of effective and total tillers $hill^{-1}$, number of grains $panicle^{-1}$, grain and straw yields together with vegetable and rice equivalent yields were influenced significantly by the interaction of crop combination and width of *ail* treatment except panicle length (Table 3). Plant height differed significantly due to the interaction effect. The results showed that there was no significant difference among the treatment combinations (Table 3). Number of effective tillers $hill^{-1}$ was significantly different due to the effect of interaction between crop combination and width of *ail*. The highest number of effective tillers $hill^{-1}$ (16.27) was found in the C_0A_4 treatment combination and the lowest number of effective tillers $hill^{-1}$ (12.47) was obtained from C_4A_4 treatment combination. Effect of interaction between crop combination and width of *ail* for number of total tillers $hill^{-1}$ was significant. The results showed that higher number of total tillers $hill^{-1}$ (20.00) was found in the C_0A_4 treatment combination and the lower number of total tillers $hill^{-1}$ (14.67) was obtained from the C_3A_2 treatment combination. There was significant interaction effect on number of grains $panicle^{-1}$. It was found that the maximum number of grains $panicle^{-1}$ (149.3) was produced by the C_0A_4 treatment combination. The minimum number of grains $panicle^{-1}$ (123.0) was

Table 3. Yield and yield attributes of *Boro* rice cv. BRRI dhan29 as influenced by the interaction of crop combination and width of *ail* in the rice cum vegetable cultivation system

Crop combination X Width of *ail*	Plant height (cm)	No. of effective tillers hill^{-1}	No. of total tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Vegetable yield (tha^{-1})	Rice equivalent yield (tha^{-1})
C_0 X A_1	92.47abc	14.40c~h	17.33bc	23.25	139.5a~d	7.21a	8.29a	-	7.21hi
C_0 X A_2	95.12a	15.00b~e	17.13bc	22.77	142.2abc	6.65a~d	7.66a~e	-	6.65i
C_0 X A_3	93.87ab	15.40abc	17.67b	23.72	145.1ab	6.93abc	7.85abc	-	6.93hi
C_0 X A_4	87.24d	16.27a	20.00a	22.09	149.3a	7.00ab	8.07ab	-	7.00hi
C_1 X A_1	89.68bcd	15.93ab	19.06a	22.92	136.2a~d	6.38a~d	7.36a~e	3.81fg	9.96h
C_1 X A_2	91.47abcd	13.53gh	15.80d~g	23.27	137.5a~d	6.55a~d	7.57a~e	7.43de	13.54g
C_1 X A_3	91.84abc	15.13b~e	17.66b	23.49	138.3a~d	6.71a~d	7.75a~d	13.08c	19.02cd
C_1 X A_4	91.40abcd	15.27bcd	17.87b	23.12	134.6b~e	6.28bcd	7.12c~f	13.21c	18.71cde
C_2 X A_1	91.48abcd	13.60gh	16.13c~f	23.58	131.8b~e	5.86de	6.82def	15.84b	20.77bc
C_2 X A_2	91.55abcd	14.13e~h	17.00bcd	23.70	126.8de	5.90de	6.79ef	9.84d	15.15fg
C_2 X A_3	92.60abc	14.27d~h	17.34bc	23.05	148.8a	6.04de	6.95c~f	18.44ab	23.40ab
C_2 X A_4	91.98abc	14.40c~h	15.20fg	23.40	136.1a~e	6.07cde	7.11c~f	18.78a	23.75a
C_3 X A_1	89.13cd	13.93fgh	15.33fg	23.33	133.3b~e	5.89de	6.86def	2.74gh	8.47hi
C_3 X A_2	89.13cd	13.40h	14.67g	23.36	135.0b~e	6.37a~d	7.22b~f	1.59gh	7.86hi
C_3 X A_3	94.50a	15.33abc	17.93b	24.09	136.6a~d	6.61a~d	7.61a~e	1.60gh	8.12hi
C_3 X A_4	92.22abc	14.40c~h	16.93bcd	23.59	139.3a~d	6.68a~d	7.66a~e	3.18fg	9.67hi
C_4 X A_1	92.38abc	14.13e~h	15.33fg	23.57	143.3abc	5.43e	6.40f	7.41de	15.89efg
C_4 X A_2	92.53abc	14.53c~g	15.60efg	23.31	123.0e	4.67f	5.32g	5.91ef	13.02g
C_4 X A_3	91.17abcd	14.67c~f	16.20c~f	22.99	131.5cde	6.41a~d	7.39a~e	7.45de	16.92def
C_4 X A_4	91.72abc	12.47i	16.67b~e	23.75	134.2b~e	6.32bcd	7.28b~f	7.54de	16.97def
Level of significance	0.05	0.01	0.01	NS	0.05	0.05	0.05	0.01	0.01
CV (%)	2.49	3.71	3.93	3.60	4.95	6.94	6.65	22.95	12.60

In a column, the treatment means having similar letter(s) do not differ significantly, 'NS' means not significant, C_0: Rice (Sole), C_1: Rice + Bottle gourd (Bo), C_2: Rice + White gourd (W), C_3: Rice + Sponge gourd (S), C_4: Rice + Yard long bean (Y) ; Note A_1: 30 cm, A_2: 40 cm, A_3: 50 cm, A_4: 60 cm

obtained from C_4A_2 treatment combination. Grain yield of rice cv. BRRI dhan29 differed significantly due to the effect of interaction between crop combination and width of *ail*. The highest grain yield (7.21 t ha^{-1}) was obtained from sole rice with 30 cm width of *ail* (C_0A_1) and the lowest value (4.67 t ha^{-1}) was recorded from rice + yard long bean with 40 cm width of *ail* (C_4A_2) treatment combination. Straw yield significantly differed due to the interaction effect. Higher straw yield (8.29 t ha^{-1}) was produced from the C_0A_1 treatment combination and lower straw yield (5.32 t ha^{-1}) was recorded from C_4A_2 treatment combination. Higher straw yield might be due to the production of longest plants. In vegetable cultivation with *Boro* rice, white gourd (C_2) with 60 cm (A_4) and 50 cm (A_3) *ail*s gave the highest yield (18.78 and 18.44 t ha^{-1}, respectively). The second highest vegetable yield (13.21 and 13.08 t ha^{-1}, respectively) was produced from bottle gourd (C_1) with the same width of *ail* treatments. The A_1 (30 cm) and A_2 (40 cm) width of *ail*s with all the vegetable crops gave more or less the lowest yield. Results showed that the highest rice equivalent yield (23.75 t ha^{-1}) was obtained from C_2A_4 (rice + white gourd and 60 cm width of *ail*), which was similar to C_2A_3 (23.40 t ha^{-1}) treatment combination and the lowest rice equivalent yield (6.65 t ha^{-1}) was received from the control treatment.

Cost analysis

In respect of cost analysis for vegetable cultivation with *Boro* rice, the highest gross return (Tk. 208,985ha^{-1}), net return (Tk. 149,049ha^{-1}) and benefit-cost ratio (3.49) were obtained from the treatment combination of rice + white gourd and 60 cm width of *ail* (C_2A_4) and the lowest gross return (Tk. 74,030ha^{-1}), net return (Tk. 17,256ha^{-1}) and benefit-cost ratio (1.30) were obtained from rice + sponge gourd and 40 cm width of *ail* (C_3A_2) treatment combination (Table 4). The results also showed that 50 to 60 cm width of *ail*s are adequate to grow those vegetable successfully. It appears that root growth and over-all development of vegetable crops were much better in broader *ail*s than that of narrower ones. Rice cultivation alone, because of its high input cost, is comparatively less profitable than the plot provided with both rice and vegetable on the *ail*s of the plot.

Table 4. Cost and return of vegetable cultivation along with *Boro* rice crop cv. BRRI dhan29

Treatment combination	Total cost of production (Tk. ha^{-1})	Return (Tk. ha^{-1})		Gross return (Tk. ha^{-1}) (a + b)	Net return (Tk. ha^{-1})	Marginal rate of return (%)	Benefit-cost ratio
		Due to product (a)	Due to by-product (b)				
C_0 X A_1	33,519	61,285	8,290	69,575	36,056	178.40	2.08
C_0 X A_2	33,519	56,525	7,660	64,185	30,666	151.73	1.91
C_0 X A_3	33,519	58,905	7,850	66,755	33,236	164.45	1.99
C_0 X A_4	33,519	59,500	8,070	67,570	34,051	168.48	2.02
C_1 X A_1	61,368	84,660	7,360	92,020	30,652	65.91	1.50
C_1 X A_2	61,368	115,090	7,570	122,660	61,292	131.79	2.00
C_1 X A_3	61,368	161,670	7,750	169,420	108,052	232.33	2.76
C_1 X A_4	61,368	159,035	7,120	166,155	104,787	225.31	2.71
C_2 X A_1	59,936	176,545	6,820	183,365	123,429	273.49	3.06
C_2 X A_2	59,936	128,775	6,790	135,565	75,629	167.58	2.26
C_2 X A_3	59,936	198,900	6,950	205,850	145,914	323.31	3.43
C_2 X A_4	59,936	201,875	7,110	208,985	149,049	330.26	3.49
C_3 X A_1	56,774	71,995	6,860	78,855	22,081	52.46	1.39
C_3 X A_2	56,774	66,810	7,220	74,030	17,256	41.00	1.30
C_3 X A_3	56,774	69,020	7,610	76,630	19,856	47.18	1.35
C_3 X A_4	56,774	82,195	7,660	89,855	33,081	78.60	1.58
C_4 X A_1	52,673	135,065	6,400	141,465	88,792	232.76	2.69
C_4 X A_2	52,673	110,670	5,320	115,990	63,317	165.98	2.20
C_4 X A_3	52,673	143,820	7,390	151,210	98,537	258.31	2.87
C_4 X A_4	52,673	144,245	7,280	151,525	98,852	259.13	2.88

Note: A_1: 30 cm, A_2: 40 cm , A_3: 50 cm, A_4: 60 cm; C_0: Rice (Sole), C_1: Rice + Bottle gourd (Bo), C_2: Rice + White gourd (W), C_3: Rice + Sponge gourd (S), C_4: Rice + Yard long bean (Y) ; Rice grain @ Tk. 8.50kg^{-1} ; Bottle gourd @ Tk. 8.00 kg^{-1} ; White gourd @ Tk. 8.00 kg^{-1}; ce straw @ Tk. 1.00 kg^{-1} Sponge gourd @ Tk. 8.00kg^{-1} ; ard long bean @ Tk. 12.00 kg^{-1}

References

Alam, M. Z. 2000. Dike cropping manual. Interfish- 2 Project. CARE (Co-operative for American Relief Everywhere), Bangladesh.pp. 28-49.

Amin, A. K. M. R. 2004. Effect of cold temperature and agronomic management on the spikelet sterility and yield of *Boro* rice. Ph. D. Thesis, Dept. Agron., Bangladesh Agril. Univ., Mymensingh. pp. 52-57.

BBS (Bangladesh Bureau of Statistics). 2004. Monthly Statistical Bulletin Bangladesh. Bangladesh Bur. Stat., Stat. Div., Min. Planning, Govt. People's Repub. Bangladesh. pp.53 & 57.

BRRI (Bangladesh Rice Research Institute). 2004. *Adhunik Dhaner Chash* (In Bengali). 10th Ed. Booklet No. 5. Bangladesh Rice Res. Inst., Joydebpur, Gazipur, Bangladesh. pp. 25-28.

FAO (Food and Agriculture Organization). 1998. Quarterly Bulletin of Statistics. Food and Agriculture Organization of the United Nations, Rome, Italy, 11(314): 91-92.

Gomes, K. A. and Gomes, A. A. 1984. Statistical Procedure for Agricultural Research. 2nd Ed. John Willey and Sons. New York. pp. 97-111.

Kundu, S. K. 2002. Vegatable production in *Boro* rice crop. M.S. Thesis, Dept. Agron., Bangladesh Agril. Univ., Mymensingh. p. 64.

Siddique, M. A. and Aditya, D. K. 1992. Vegetable consumption and nutrition status in Bangladesh. In: Vegetable production and Marketing; Proc. National Review and Planning Workshop, AVRDC, Shauhua,